ZOOGOER

JULY • AUGUST 1994

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ZOOGOER

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Friends of the National Zoo

is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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A GIANT THANKS

"Giants" turned out to be the perfect theme for ZooFari 1994: Our biggest ZooFari ever was a giant success. This year, 12 groups of entertainers took the stage while 97 restaurateurs served up their phenomenal fare to the 2,800 guests who partied the night away. With all the numbers in, ZooFari's net proceeds exceeded $200,000, a new record.

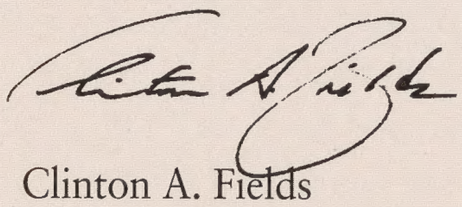
As you may know, ZooFari proceeds go to the Theodore H. Reed Animal Fund; this fund helps the Zoo exhibit, breed, and educate about rare and endangered species. Money from last year's ZooFari was used to enhance the Amazonia Exhibit (about $40,000), for landscaping in other exhibits and areas in the Zoo ($31,000), and to pay for Shanthi's room and board at the Burnet Park Zoo ($5,000). Remaining funds have been designated to improve other exhibits throughout the Zoo.

There are many people to thank for the resounding success of this year's ZooFari—from nearly 200 dedicated volunteers, to the remarkable staffs of the Zoo and FONZ, to our generous underwriters and benefactors. FONZ volunteers created decorations, set up for the event, tended bars, worked registration tables, ran Barrels of Monkeys and Fling for Flight, cleaned up after the party, and helped with countless other essential tasks. ZooFari would be impossible without the help of these selfless people.

This year, the Coca-Cola Company, a long-time supporter, was joined by Black Entertainment Television, Continental Airlines, The Purina Big Cat Survival Fund, and WUSA-TV in the ranks of ZooFari underwriters. Once again, our benefactors Calvert Woodley Wine and Liquors and the Omni Shoreham Hotel were unstinting in their generous support of ZooFari, as were two new benefactors, District Cablevision and Torresella Wines. Four local radio stations, WGMS, WKYS, WMAL, and WXTR, provided ever-essential publicity for ZooFari. A special thank you goes to Jane Gaston, whose art has graced ZooFari many times before, and who donated her original *Elephants* painting to "Giants." Special thanks also goes to Miriam Carmack, FONZ board member, who brought all of the fabulous restaurants to ZooFari.

Finally, I want to thank the largest group of ZooFari supporters: our guests. To all the FONZ members who purchased tickets and tables, thank you very much. I hope you enjoyed "Giants," and I look forward to seeing you at our 1995 ZooFari.

Sincerely,



Clinton A. Fields
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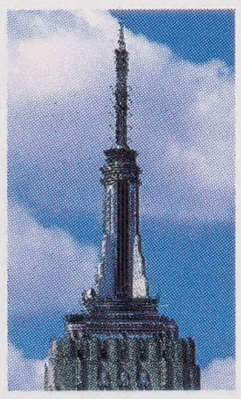

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Little Boy

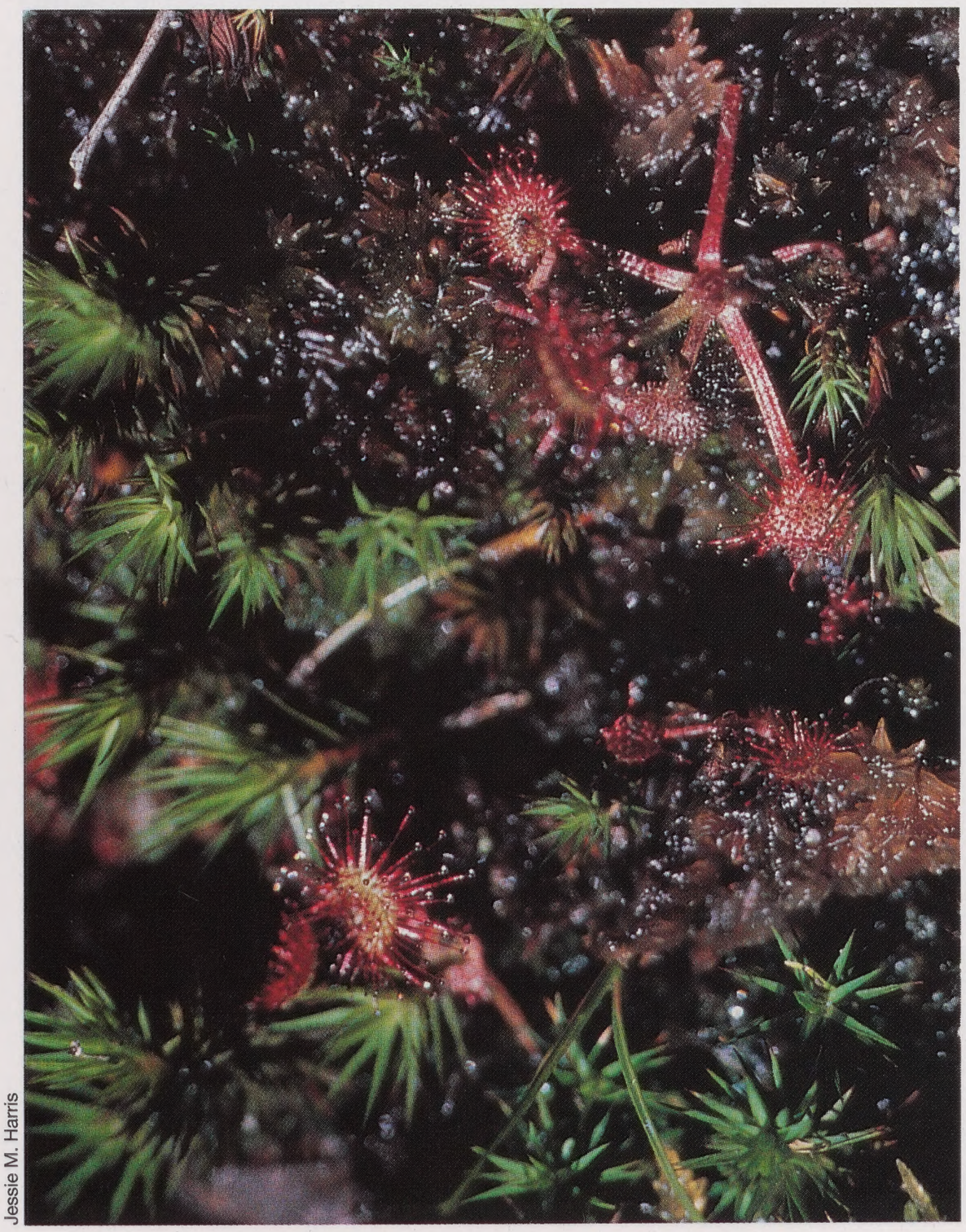
PHYLLIS ZAUNER

The unsuspecting fly buzzes, circles, and makes what is destined to be its final landing, on an odd-shaped, twin-lobed leaf. It will walk the dangerous terrain for only a few moments before triggering hairlike projections. Then the Venus's-flytrap will snuff out its life with a device more lethal than anything wielded by a villain in a James Bond movie.

Jessie M. Harris

Venus's-flytrap.

# of Horrors



Jessie M. Harris

Attracted by the smell of nectar, a honeybee lights at the glistening mouth of an upright, tubular leaf and begins to feast. One false step later the hapless bee tumbles like Alice in Wonderland down the dark throat of the pitcher plant. What follows could hardly be described as a tea party.

Meet the meat eaters of the plant world. Mysterious and intriguing, they have acquired, in the course of evolution, the remarkable ability to attract, capture, and digest living animal prey. They are the Venus's-flytraps, pitcher plants, sundews, and bladderworts, dressed to kill in communion white, buttery yellow, pouty pink, and seductive red. As if all of these come-hither hues weren't enough, nearly all species are pungently scented.

Early botanists realized that certain plants attracted insects, but didn't realize they were digesting them. In 1760, Governor Arthur Dobbs of North Carolina first applied the term "carnivorous" to what would later be called the Venus's-flytrap (*Dionaea muscipula*). Charles Darwin called the flytrap, so well outfitted for survival, the "most extraordinary plant in the world," and experimented with it and other carnivorous plants. He published the results of his research in *Insectivorous Plants* (1875), even today a standard reference.

Round-leafed sundew.

The mysterious allure of carnivorous plants is an ecumenical one. At first, the idea of flesh-eating plants leaves some people incredulous, says Joe Mazrimas, founder of the International Carnivorous Plant Society. "Then there's the strange thrill in seeing a savagely beautiful plant snap shut on an insect. It's like turning the tables. Those plants are saying, 'You try that on me, sucker, and you get the trap.' Their ability represents a kind of revenge." Undoubtedly, the Venus's-flytrap's dramatic ability to move with uncanny speed and chomp its prey is what makes it the most popular carnivore among devotees.

The Venus's-flytrap is a mechanical marvel. A small plant with a poor root system, its leaves are bright red in sunshine, green in shade.

At the end of each leaf are two hinged lobes with a fringe of teeth along the edges—this is the trap. Insects are lured to the open trap by the sweet scent of nectar. Inside the trap are tiny trigger hairs, three on each side. Here's where the plant determines the edibility of what has landed. If only one hair is hit, nothing happens—it could be a leaf or a twig. But if one hair is hit twice within 20 seconds, or if two hairs are touched simultaneously, the plant perceives a moving object, probably tasty. The concave outer side of the leaf instantly puffs up and the trap snaps shut. But it still hasn't clamped tight. If the prey is insignificant, it can escape. But if it struggles, further irritating the trigger hairs, the leaf will close as tight as an envelope and release digestive enzymes. When it unfurls, as long as one to two weeks later, only the hard, chitinous exoskeleton of the unfortunate visitor will remain.

Although the nutrients have been removed, sometimes the exoskeleton of a fly remains intact and rewards the plant with a second meal. It may give a passing spider the notion that it's dinner time. Approaching the corpse, he quickly learns that it's dinner time all right, but that he's the entree.

© Les Saucier: Photo/Nats

In western Florida, a Venus's-flytrap prepares to make a meal of a colorful seepage dancer.

Milton H. Tierney, Jr.

A spatulate-leafed sundew in southern Maryland.

Spanning the Globe

Twenty years ago, only 450 species of carnivorous plants had been documented. Since that time, the number has risen by about 100, and new discoveries are continually being made, particularly among bromeliads in the Amazonian rainforest.

Seventeen genera of carnivorous plants grow around the world, from the Arctic Circle to the southernmost tropics. Generally they inhabit wet areas—bogs, seasonal wetlands, and mossy forests. They're believed to have evolved carnivorous adaptations to compensate for the dearth of essential mineral salts in the acidic soils in which they live. Carnivorous plants photosynthesize, grow, flower, and otherwise behave like other green plants. They're different primarily in their ability to absorb nutrients from captured prey.

Among the carnivorous plants with traps that can move are the sundews—the *Drosera* species—given their common name because of the way the droplets of their secretions sparkle in the sun. There are five native North American species; most of the nearly 100 *Drosera* varieties are found in the southern hemisphere. Their secretions, which coat the stalky glands that line the sundew's leaf, include a powerful adhesive. Each tentacle-shaped leaf may have 130 to 250 sticky glands. When insects are caught in the glue, the leaf curls around the prey and secretes digestive juices that break down their softer parts, absorbing the re-

Milton H. Tierney, Jr.

A female nursery web spider finds the mouth of this purple pitcher plant an attractive place to build a web for her young.

sulting nutrient-rich solution.

Sundews feed primarily on flies or butterflies. Charles Darwin tried feeding a sundew sand and glass, but the plant wouldn't grasp them. When he offered it beef, the leaf edges curled in, the meal was digested, and the leaves reopened. Clearly, the sundews have a preference for protein. Merilee Maertz, co-owner of a Sonoma County nursery, California Carnivores, says their sundews have accepted eggs, cheese, and even human hair. "But we don't do that often, because we think it's not good for them." Signs in their greenhouse caution visitors, "Don't tease the plants."

Another sticky plant is the Portuguese sundew, or dewy pine (*Drosophyllum lusitanicum*), a shrub that grows up to five-feet tall on the dry coastal hillsides of Portugal, Spain, and Morocco. Its trapping and digestive mechanisms are much like those of other members of the sundew family. The linear leaves have many glands that secrete a mucilage with the wonderful aroma of honey. Attracted by the scent, mosquitoes, midges, and small flies light on the leaves, suffocate as they become mired in the mucilage, then are leached of nutrients by digestive enzymes.

Pitchers, Butters, and Bladders

Even more enticingly dangerous are the pitcher plants—the *Sarracenia* species. Except for the purple pitcher plant (*S. purpurea*), which is found as far north as Canada, they are natives of the southeastern United States. Pitcher plants can grow to three feet or more and produce showy, trumpetlike "pitchers" (actually modified leaves), open at the top and surmounted by a flaring hood.

Here is a bug's worst nightmare. An insect, attracted by the irresistible scent of the

© Don Johnston: Photo/Nats

plant's nectar, begins exploring the pitcher's lip, or nectar roll, and soon finds itself plunging downward, any hope of retreat cut off by many backward-pointing hairs. Nectar forgotten, the bug tries to escape, but it can't make a path against the pointed field. Weary from the struggle, it next encounters a smooth, hairless region where there is no footing at all. The end is near. Falling into the bottom of the trap, it ends up being digested by enzymes and bacteria.

Related to the *Sarracenia*, the California pitcher plant (*Darlingtonia californica*), dispatches its prey in a similar manner. Also called the cobra lily for the deadly snake it resembles, this plant presents an even more ingenious trap. The pitcher ends in a flaring dome, with an appendage that looks like a forked tongue dangling from its mouth. The variegated red and green tongue produces nectar, as does the nectar roll on the lip of the opening. Once the unwitting insect lands, translucent windows in the wall of the hood create an illusory openness, and the poor bug enters believing it's got an escape hatch. As in other pitcher plants, a combination of backward-pointing hairs and slippery patches ushers the prey to its doom in a pool of seething bacteria.

Another genus of pitcher-type plants is *Nepenthes*, whose distribution is concentrated in the Malay Archipelago, with species also found in Sri Lanka, China, the Philippines, and northern Australia. These tropical versions differ from other pitcher plants in that most are climbers, ascending as high as 50 feet above the jungle floor. As in all pitcher plants, the urns are passive, filled with liquid in which the prey drowns after being attracted by the nectar. Once in a great while some tropical pitchers bag bigger game. The remains of scorpions, rodents, and small reptiles have been discovered in the giant urns of larger *Nepenthes*, which in some species can get to be over a foot tall and about half as wide.

More common are butterworts in the

*A sundew (*Drosera anglica*) with its damselfly prey.*

A cobra lily flower with a crane-fly caught in a spider web.

© Jo-Ann Ordano: Photo/Nats

genus *Pinguicula*. About 50 butterwort species are distributed throughout the world; several are native to North America. These pale-green plants lie flat along the ground and produce attractive violetlike flowers. Small insects are attracted by their mushroomy odor and become trapped in the sticky glands covering the leaves, which subsequently curl up in a shallow bowl, not to clutch the victim but to form a pool for the secreted enzymes. The common name derives from their use in Scandinavian countries to curdle milk and produce a delicious cheese. In Switzerland, farmers rub butterwort leaves on cattle sores and find them healed within a few days.

Not to be confused with the butterworts are the bladderworts (*Utricularia*). The more than 200 species of this genus grow all over the world and illustrate the astounding variation in modus operandi among predatory plants. These strange rootless plants grow in mosses or float free in aquatic environments, and their tiny, pinhead-sized bladders are the fastest moving traps in the world. Guide hairs direct minute creatures toward small triggers, which cause a trap door to open so rapidly that the prey is sucked inside. The trap closes again within a thousandth of a second.

At least two bromeliads are known to be carnivorous. Like many bromeliads, *Brochinea reducta* and *Catopsis berteroniana* grow epiphytically on trees, absorbing moisture and nutrients from the rainwater and wind-borne debris that collect in their cupped leaves. But, unlike other bromeliads, these carnivorous species exude a slippery, waxy powder that causes insects to lose their grip and slip into the leaf cups to be digested.

Carnivorous plants are represented among the distinct flora of Australia by the rainbow plants—the two-foot *Byblis gigantea* and the four- to eleven-inch *B. liniflora*—which have delicate pink to purple five-petaled flowers. Their long, slender leaves are covered with glandular hairs that catch insects attracted to the shining drops of sticky mucilage. The more the insect struggles, the more mucilage the plant produces. Finally, the insect comes in contact with other microscopic glands that secrete digestive juices and put an end to its struggles. At times, a plant will be almost completely covered with insects waiting to be digested.

Threatened Carnivores

Watching carnivorous plants in action is great entertainment, but there is a sobering side to their story. Many species are disappearing as their wetland habitats are developed out of existence.

North American wetland areas have declined by about 50 percent since Europeans arrived 400 years ago, most of them drained to provide land for farms, housing tracts, and other forms of development. Some wetland habitats have declined even further. Nearly 2,000 square miles of bogs, home to four species of pitcher plants as well as sundews, bladderworts, and butterworts, once extended along the Gulf coast from western Florida to eastern Louisiana. Today, about 45 square miles of bogs remain, only a fraction of which are relatively pristine.

In addition to the problem of disappearing wetlands, another threat to carnivorous plants is that fires, which once burned back the brush in forests, are now so well controlled that carnivores are choked out by rampant scrub brush, even in areas where wetlands exist.

Finally, many of the most sought-after carnivorous plants are suffering from overcollecting and poaching. Venus's-flytraps, for instance, are endangered in both North and South Carolina, the only places where they are still found. Even there, they occur only in small stands in restricted bog habitats. But, when flytraps were numerous in the Carolinas, collecting had little effect on wild populations. With the natural habitat of the flytraps disappearing, however, the plants can be found in only a few places and collecting and poaching of wild plants threatens the species' survival.

The Venus's-flytrap was placed on Appendix II of the Convention of International Trade in Endangered Species (CITES) listing in March 1992. This allows for the export of wild plants only under carefully monitored conditions. But, as species become more rare, illicit trade becomes more tempting. One racket was uncovered in which Venus's-flytraps in the United States were poached during their dormant winter season, shipped to Holland at 15 cents per bulb, grown in greenhouses, and then resold at high prices to other countries—including the United States—without going through the permits that are required of commercial propagators.

North Carolina nurseries export more than a million Venus's-flytraps each year, most claiming that they grow their own flytraps. However, Vonda Frantz, a World Wildlife Fund investigator, found in her 1992 survey of nine North Carolina nurseries that all but one were using bulbs and clippings obtained from wild-dug plants as the source of their flytraps.

Worst of all, most of the Venus's-flytraps, sold in huge quantities as novelties, are destined to perish within days from neglect.

Two other popular genera of North American insectivorous plants are also threatened by overcollection: *Sarracenia*, the trumpet pitchers, and *Darlingtonia*, the cobra lily. Three species of *Sarracenia* are listed on CITES Appendix I, which bans all international trade in wild plants. All other species of *Sarracenia* and *Darlingtonia* are listed on Appendix II. The *Darlingtonia* is also protected by a federal law that bans the export of wild plants. But still, Don Schnell, one of the world's foremost *Sarracenia* experts, writes in the *Carnivorous Plant Newsletter* that when people contact him about locating and photographing stands of carnivorous plants, he can name only two places, whereas he knew of a dozen a few years ago.

The same situation exists in other parts of the world. In southwest Australia, for instance, the sundews and a rare pitcher plant, *Caphalotus follicularis*, have been crowded out. In Borneo, *Nepenthes rajah* has been almost completely removed from the wild. This stunning plant, with glossy-red pitchers the size of a football, now lives in only a few areas of Mount Kinabalu National Park. Even though it has been listed on CITES Appendix I since 1981, it is still in danger from collectors who will pay poachers $1,000 for a healthy plant.

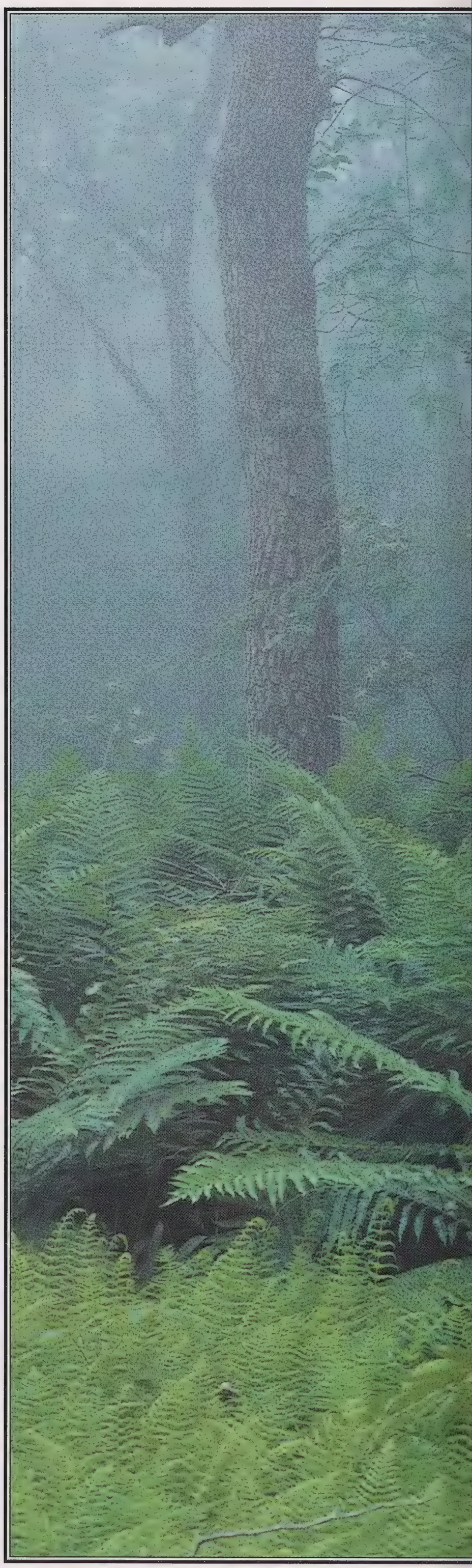
Collecting carnivorous plants from the wild is largely unnecessary (not to mention illegal) because most are artificially propagated in nurseries and available for purchase. But before you buy, question your source about its suppliers. There's no reason we can't have these charming eccentrics in our hothouses, while leaving their wild brethren to go on trapping and munching.

Phyllis Zauner is a freelance writer who lives in Sonoma, California. This article first appeared in American Horticulturist *magazine.*

Meanders with Salamanders

Robert Jaeger leads the way through the dense Appalachian woods, a pronged garden hoe slung over his shoulder. Jaeger stops every now and then to turn over a rock or log, or to rake through the leaves on the forest floor. The beams of coal-miner-style headlamps and hand-held flashlights pierce the otherwise dark, humid summer night.

"See, I told you they climb trees," cries Jaeger, a biologist at the University of Southwestern Louisiana in Lafayette. Pointing to a nearby spruce where a half dozen redback salamanders cling, he adds, "Look at that big, fat one crawling down. He's probably eaten his fill and is heading for home."



Jeffrey P. Cohn
Photographs by John E. Fauth

With thin bodies, long tails, and legs splayed out reptilelike from their sides, salamanders are often mistaken for lizards. In the Appalachians, people frequently call them "spring lizards," because of the dusky salamander's propensity to dwell in or near springs and small streams. In fact, however, salamanders are amphibians, related to frogs, toads, and caecilians (wormlike tropical animals). Unlike reptiles, salamanders have clawless feet, a smooth, sometimes slimy skin rather than scales, and gelatinous rather than shelled eggs. And, unlike frogs and toads, they have a tail even as adults.

The name "salamander" comes from an Arab–Persian word meaning "lives in fire." A once widely believed European legend told that the animals were unharmed by flames. The aptly named fire salamander, a brightly colored European species, probably served as the basis for this legend. Often dwelling in logs, the fire salamander would hastily flee its home when the wood was thrown on a fire.

Duskies, Redbacks, and More

The fire salamander's name may be appropriate, but those of others can be downright confusing. For starters, take the dusky salamanders. There are dusky, mountain dusky, northern dusky, southern dusky, and Ouachita dusky salamanders—among others—all separate species. There are also 13 species or subspecies of slimy salamanders, five of tiger salamanders, and four of spring salamanders.

To add to the confusion, consider the redback salamander. Not only is there a redback and a southern redback salamander, but also a "leadback," a dark-gray to black phase of redbacks that lacks the red line down its back and tail, which normally identifies the species.

Then there are zigzag salamanders, which differ from redbacks chiefly in their possessing a wavy line instead of a straight one on their backs and tails. Further, there are eastern and Ozark zigzag salamanders. Like the redback, the latter's stripe is often more straight than wavy.

Regardless of their precise species designation, common name, or color, salamanders are shy, secretive creatures that are rarely seen by people who are not looking for them. Most remain hidden during the day in rotting tree stumps, burrowed in the ground, or under rocks, leaves, or fallen

The red salamander, a common but secretive salamander of the eastern United States.

logs. They typically emerge to feed or mate only at night.

One exception is the red eft, the juvenile stage of the red-spotted newt. Newts are rough-skinned salamanders that spend most of their lives in water. Unlike in its earlier larval and later adult stages, however, the reddish-orange eft lives on land. There, it walks above ground during the day apparently oblivious to danger. The reason: Its bright color warns most would-be predators that the eft is poisonous.

Not only are most salamanders secretive, they are also small. Most measure less than six inches from head to base of tail and weigh only a few ounces. Two notable exceptions are the Chinese and Japanese giant salamanders, the world's largest salamanders. The former can reach nearly six feet in length and weigh more than 80 pounds, while the latter measures about five feet.

Closer to home, the hellbender, an American relative of the giant salamanders, can reach two-and-a-half feet in length. An aquatic species, the hellbender lives in Appalachian, Ohio River Valley, and Ozark Mountain streams. It often dines on crayfish, which it sucks into its mouth. Rather than swallow right away, however, the salamander waits while the crayfish tries to find a way out.

When the luckless crustacean moves to face forward, the hellbender gulps it down tail first.

Cannibalistic Salamanders

All salamanders are predators, usually eating insects, worms, spiders, snails, slugs, and other small invertebrates. In addition to crayfish, aquatic salamanders prey on fish, frog eggs, tadpoles, leeches, and mollusks. Many salamanders will even eat other, smaller salamanders, occasionally including their own kind.

On Lake Superior's Isle Royale, for example, blue-spotted salamander larvae (often called tadpoles, like the frog and toad larvae they resemble) will nibble on each other's legs, tails, or external gills if too many occupy the same pool. "They're generalized predators," explains Josh Van Buskirk, a researcher at the Institute of Ecosystems Studies in Millbrook, New York. "They eat anything that moves."

Even stranger goings-on occur in Arizona ponds. There, much like other salamander larvae, tiger salamander tadpoles eat aquatic insects, plankton, worms, and small shellfish. But, some of those tadpoles grow larger than others and develop wider heads and enlarged teeth. Thus equipped, they eat other tiger salamander tadpoles.

Although these cannibalistic tiger salamander tadpoles seem to prefer nonrelated tadpoles, they will eat their own kin, says James Collins, a zoologist at Arizona State University in Tempe. But, cannibalism among tiger salamander tadpoles is not found everywhere in Arizona, Collins discovered. Cannibalism is more common in central Arizona mountain ponds, he says, less common in eastern Arizona, and rare in the north.

The reason for its rarity in the north, Collins believes, is a bacterial infection that kills thousands of salamander tadpoles each August in ponds north of the Grand Canyon.The pathogen's growth is apparently enhanced by cattle dung washed into the ponds. If healthy tadpoles in northern Arizona ate other, infected ones, they could become sick

A female southern two-lined salamander with eggs.

and die. "There's a real cost to becoming a cannibal," Collins concludes.

Neoteny Among the Newts

An even more interesting phenomenon occurs among some salamander species: they refuse to grow up. Neoteny, as scientists call the phenomenon, can take many forms. In one, salamanders fail to undergo metamorphosis, the process by which amphibians change from aquatic-dwelling tadpoles to full-fledged adults. Instead, they retain external gills, a fishlike tail, and an aquatic existence. They do, however, become sexually mature and reproduce like other salamanders.

Neoteny is common among aquatic and cave-dwelling salamanders, as well as among tiger salamanders in the western United States. But perhaps the best-known neotenous salamander is the axolotl. Named for an Aztec word meaning "water monster," axolotls are found only in Lake Xochimilco in southern Mexico. There, they spend all their lives in a larval form.

Axolotls and a dozen other closely related Mexican salamanders live in ponds or lakes, some of which are surrounded by dry, hot terrestrial habitats normally not well-suited for salamanders. These Mexican salamanders include some species that undergo metamorphosis, as well as others that have both neotonous and metamorphosed forms, depending on their specific habitats. But only axolotls fail to undergo metamorphosis at all.

"Neoteny is a mechanism for remaining aquatic," says Bradley Shaffer, a University of California at Davis ecologist. "It allows some salamanders to avoid transforming into adults when their terrestrial habitat is inhospitable."

For salamanders, hospitable habitats usually are moist, northern temperate forests worldwide. Within that range, the Appalachian Mountains and southeastern United States have more individuals and greater diversity of salamander families than anywhere else.

Nine of the ten recognized salamander families are found in North America. Five exist nowhere else.

Interestingly, however, more salamander species live in Central and South America. More than a third of the world's salamander species are found from northern Mexico south into Brazil and Bolivia. But, all except the axolotl and its relatives belong to one tribe of a single family. Indeed, that family, the plethodontids, comprises about 230 of the 380 known salamander species.

Plethodontids are the only vertebrates to have no lungs or gills. Instead, they breathe through their skin or the mucous membranes in their mouths. More than other salamanders, plethodontids must keep their skin moist. Thus, most are active only at night when rain, mist, or fog has raised humidity levels.

Still, some plethodontids live on dry ground far removed from water. The best-known is the redback salamander. Redbacks live such completely terrestrial lives that they do not even return to water to lay eggs. Instead, they deposit them in moist places under rocks, fallen logs, or tree bark. And, instead of abandoning the eggs to fate, the female guards them until they hatch. The young emerge not as tadpoles, but as miniature versions of their parents.

Competition for Habitat

In contrast to the redback, which ranges from Hudson Bay to North Carolina and west to the Mississippi River, some salamanders are limited to one or two mountain tops. The white-spotted, or Cow Knob salamander, for example, lives only on a few mountains in northwestern Virginia, while the Cheat Mountain salamander inhabits only a few West Virginia peaks.

In part, the limited range of the Cow Knob and Cheat Mountain salamanders

The redback salamander, North America's most common salamander species.

The seal salamander is found in moist, streambank habitat.

A spring salamander at the Mountain Lake Biological Station.

may be due to the animals' dependence on specific habitat that varies from mountain to mountain, or to an inability to cross the low valleys between mountains. But it may also be due to competition from other salamanders.

Take the case of the Shenandoah salamander, an endangered species found only in rocky areas on the northwest faces of just three peaks in Virginia's Shenandoah National Park. The rocks, hotter and drier than the surrounding forest, are "awful habitat for salamanders," says Robert Jaeger.

Jaeger has studied competition between the Shenandoah and redback salamanders. He found that redbacks will bite off and eat the tails of salamanders, including Shenandoahs and other redbacks. "Redbacks are a very aggressive species," he says.

Incidentally, if attacked, many salamanders can voluntarily shed their tail and later regrow it. This allows them to escape predators, but not without cost. A tailless salamander loses an important source of fat reserves and, for a while at least, has little or no tail to shed when next attacked.

More important, Jaeger has also seen, both in the field and in the laboratory, redback salamanders bite the snout of Shenandoah and other salamanders. By so doing, redbacks may damage their opponents' nasolabial groove, a small chemical-sensing structure of plethodontid salamanders, extending from the nasal opening to the upper lip. If this structure is damaged, an animal might lose its ability to smell, an important sense for salamanders.

In fact, chemical signals may play a more important role for salamanders than sight in differentiating among themselves. In one study, biologist Stephen Tilley placed mountain dusky salamanders from different geographical regions together in the same aquarium in his laboratory at Smith College in Northampton, Massachusetts.

Tilley found that courting behavior between individual mountain dusky salamanders decreases as the distances between the animals' home ranges increases. Similarly, he found that genetic differences increased with geographic separation.

"There are probably three mountain dusky salamander species, not just one," Tilley concludes. "It doesn't matter that they look alike to humans. What matters is how they behave towards each other. Salamanders operate on chemical, not visual, cues."

Another scientific study addresses how competition affects habitat choice among salamanders. At the University of Virginia's Mountain Lake Biological Station in southwestern Virginia, biologist John Fauth combines up to five salamander species in long cattle troughs. The troughs contain various combinations of water, pebbles, rocks, dirt, sticks, leaves, and other natural materials arranged to re-create salamander habitats ranging from wet splash zones along stream edges to dry upland forests.

"I want to know how salamanders partition their environment," says Fauth, an assistant professor at Denison University in Granville, Ohio. He is working with redback, two-lined, northern dusky, red, and blackbelly salamanders. "I want to see how they behave relative to each other," he adds.

Fauth found that blackbelly salamanders dominate splash zones along stream margins, forcing the smaller northern dusky salamanders onto the drier banks. Not only are northern dusky salamanders driven out, they are sometimes eaten by blackbellies. In turn, northern duskies displace redbacks, forcing them even farther into the drier forest.

Fauth has confirmed his lab findings in field studies. In Ohio, which lies outside blackbelly salamander range, he has found northern duskies in the same splash zones that hold blackbellies around Mountain Lake.

For their part, blackbelly salamanders are found only in high-elevation Appalachian streams on west-facing slopes. "They have never gotten up and walked the length of a football field to streams on the east side of the divide," Fauth says. Nobody knows why.

The Human Factor

Of great concern to scientists and conservationists is the threat posed to salamanders by human activities, especially in the Appalachian Mountains. James Petranka, a biologist at the University of North Carolina at Asheville, created quite a stir when he estimated in 1993 that clear-cut logging kills more than 14 million salamanders a year in North Carolina alone.

Petranka based his estimate on two studies of more than a hundred 50-square-meter plots he and his colleagues sampled in 1991 and 1992. Petranka found that the number of salamanders varied from site to site. In one study of terrestrial sites, Petranka found 78 salamanders from eight species in areas that had not been logged for at least a century. None were found on a comparable number of recently clear-cut sites.

Petranka also estimates that, depending on elevation, 50 to 100 years of regrowth

are required following intensive logging for salamander numbers to return to levels found in mature forests. "Salamanders are really vulnerable to logging," he says. "They can't run away or hide. The leaf litter they hide under dries out and disappears after a clear-cut. Salamanders are knocked out when those moist microhabitats are lost."

Whether or not his estimate is correct, Petranka's numbers reflect how common salamanders are. While no one has precise numbers for any species, Petranka says the estimated 14 million killed each year in North Carolina probably represents less than one percent of all salamanders in that state alone.

Although no one disputes the ill effects of clear-cut logging on salamanders and other wildlife, some scientists disagree with Petranka's numbers and challenge his methods. "Petranka is off base," charges herpetologist Richard Bruce, director of the University of North Carolina's Highlands Biological Station.

For starters, Bruce questions how Petranka arrived at his estimate. "He sampled the sites just once," Bruce says. "Some of his information is useful, but not sufficient to justify grandiose estimates."

Moreover, Bruce says, not all salamanders die following a clear-cut. Some may migrate to other areas, while long-lived ones burrow underground where they may remain unseen for years. Bruce cites studies by Andrew Ash at Highlands Biological Station. Ash, a biologist at Pembroke State University in North Carolina, found that half the Jordan's and slimy salamanders that disappeared after clear-cuts returned to the same sites just 13 years later.

Petranka disagrees with Bruce. "The losses are real," he says. "If forced underground, most salamanders would starve. They feed almost entirely above ground." Petranka also says the rapid recovery Ash found is atypical and counter to the findings of other recent studies.

"I'm not worried about clear-cutting," Bruce answers. "Clear-cuts are not pretty, but they're only a temporary loss. I'm more concerned about highways and housing developments and ski resorts. That's permanent habitat loss."

Saving an Alabama Salamander

Whatever the outcome of such scientific disputes, efforts are under way to preserve salamander habitat. One project involves the Red Hills salamander, a species in the news recently. The Red Hills salamander inhabits a siltstone formation that cuts a narrow path across southern Alabama between the Conecuh and Alabama rivers. Unknown to science until 1961, this salamander is the sole member of its genus. It is rarely seen outside its underground burrows, except perhaps for a head sticking out at night looking for prey.

Listed by the U.S. Fish & Wildlife Service as a threatened species in 1976, the Red Hills salamander lives almost exclusively on privately owned land subject to logging. Of its 50,000-acre range, only 150 acres are publicly owned, says Mark Bailey, a zoologist with the Alabama Natural Heritage Program.

Secretary of the Interior Bruce Babbitt called a press conference in November 1993 to announce that the U.S. Fish & Wildlife Service and International Paper had agreed to conserve 4,500 acres of company-owned land for the Red Hills salamander. The joint habitat conservation plan is a method increasingly used by the Department of the Interior to protect endangered and threatened species. According to Babbitt, this was the first such program for a timber company in the South, and the first joint plan specifically devised to protect a salamander.

Salamanders are difficult to exhibit in zoos and aquariums, says Roger Rosscoe, a keeper at the National Zoo's Reptile Discovery Center, because they usually hide during the day. The National Zoo, which has displayed axolotls and other salamanders in the past, currently exhibits only northern red salamanders.

But other zoos and aquariums are becoming known for their salamander exhibits and conservation efforts. One is the Tennessee Aquarium in Chattanooga. Opened in 1992, the Tennessee Aquarium focuses on river habitats, including exhibits of 12 of the more than 30 salamander species that live in the Tennessee River Valley. These include lesser sirens (a long, thin, stream-dwelling species), hellbenders, and cave, mountain dusky, spring, and red salamanders.

"We realized that to accurately depict river habitats we had to have salamanders," says Greg George, a Tennessee Aquarium herpetologist. "They are good indicators of a habitat's health. They are also often the first animals kids encounter in the wild."

Farther north, the Metro Toronto Zoo has developed a habitat conservation program around frogs, toads, and salamanders. Begun in 1991, the zoo's adopt-a-pond program features books, audiotapes, posters, and T-shirts, as well as site visits, designed to inform people about amphibians and encourage them to conserve their habitats.

"We know that the loss of wetlands leads to the loss of salamanders and other amphibians," says Robert Johnson, curator of reptiles and amphibians at the Metro Toronto Zoo. According to Johnson, classes from more than 1,000 schools have adopted ponds, and 600 landowners have promised to protect wetlands on their properties since the program began.

Such conservation efforts offer hope that, although some salamanders are threatened by habitat loss, most species will continue to hold their own. For those who like to poke around under rocks, logs, and leaves, that is good news indeed.

Jeffrey P. Cohn is a freelance writer specializing in zoo and conservation issues.

The rare and endangered Shenandoah salamander.

The Derring-Do

Without the tireless efforts of dung beetles, we'd all be in deep doo-doo. These industrious beetles eat and bury dung, which keeps it from fouling the earth's surface, recycles the nutrients it contains back into the soil, and reduces the number of parasites and pests that breed in it. "They're nature's first sanitary engineers," says G. Truman Fincher of the U.S. Department of Agriculture in College Station, Texas.

. . .

Robin Meadows

Dung beetles are found nearly everywhere dung is found. Thought to have descended from beetles that ate decaying plant material, most species of dung beetles evolved on grasslands or open savannas to take advantage of the great quantities of dung produced by large grazing mammals. The greater the variety of grazers, the greater the variety of dung beetles. It therefore comes as no surprise that Africa has the most types, with more than 2,000 of the 6,000-odd known species, and that India, Southeast Asia, and South America are also rich in dung beetles. In comparison, the United States and Europe each have about 90 species.

The dung beetle's entire life revolves around dung. Adults feed on the fluids and microorganisms in fresh dung, which contain a nutritious blend of undigested proteins, and lay their eggs inside balls of dung, which then sustain the larvae until they reach adulthood.

Dung beetles typically find their food by its characteristic odor and then, depending on the species of beetle, take one of three approaches to handling it. The first approach entails using the dung for both housing and food. Beetles in this group move into dung and live there until it is all but gone, laying their eggs either in the dung or in the soil below it. These species are generally small, ranging from about a sixteenth to a quarter of an inch in length.

Beetles taking the second approach burrow into the ground directly underneath or near the dung mass and pull loose bundles

Of Dung Beetles

Jon Farrar

A pair of dung beetles (*Canthon ebenus*) atop a sand-dusted manure ball in Nebraska.

Brett C. Ratcliffe

An *Ateuchus* dung beetle rests on a leaf near Manaus, Brazil.

of dung into the burrow. These beetles are good diggers by virtue of their strong, stout legs. A pair of male and female burrowers usually works together: After the female digs out part of the burrow, the male brings her dung and she hauls it deeper into the burrow, which may extend a foot or more into the soil. The female then shapes some of the buried dung into balls and lays a single egg in each one. After the eggs hatch, the larval beetles feed on these "brood" balls.

The third approach to handling dung is the most well-known. Using "teeth" on their forelegs and heads, beetles in this group cut out rough spheres of dung and shape them into balls by rapidly running over the surface and stamping out irregularities with their forelegs. Holding the ball with their elongated, curved hind legs and pushing against the ground with their forelegs, these beetles roll the balls up to ten feet away from the main dung mass and then bury them.

Like burrowers, rollers work in pairs. Depending on the species, the female either rides the ball while the male pushes it, helps him pull the ball along, or scurries behind him as he pushes the ball to the burial site. There, he excavates soil from under the ball until both he and the ball sink underground. The female then refines the buried dung into a brood ball and lays an egg in it.

The effort involved in making and moving the dung balls is prodigious. The balls are up to five times bigger across than the beetles: The tiniest rollers make pea-sized balls and the largest make grapefruit-sized balls. While most rollers bury their dung balls between two inches to a foot deep, some of the larger species bury them up to six feet deep. After burying a dung ball, the beetles go back and start all over again. One genus of rollers is aptly named *Sisyphus*, after the figure from Greek mythology whose fate in Hades was to attempt perpetually to roll a rock up a hill, only to have it roll back upon him as he neared the top.

Super Specialists

Almost any dung will do for most dung beetles, but some are specialists and dine only on dung from particular animals. For example, some species eat only elephant dung while others eat only snail dung.

On Barro Colorado Island in Gatun Lake, Panama, two dung beetle species in the genus *Canthon* eat only dung from the mantled howler monkey (*Alouatta palliata*). These leaf-eating monkeys are brown or black and sport a yellow-brown fringe of fur on their flanks. Mantled howler monkeys live in the rainforest canopy, and, while most dung beetles fly within three feet of the ground when searching for food, the *Canthon* species fly as high as 65 feet and can locate monkey dung from a distance of more than 100 yards. Remarkably, these beetles roll the monkey dung into balls on branches and then do what it takes to get the rest of the job done: Clinging to the ball, the dung beetles plummet to the ground and bury their booty.

While most dung beetles live on the ground, some species actually live on the animals that supply their dung. Several

Bruce D. Gill

Three dung beetles (*Canthon angustatus*) roll a ball of howler monkey dung along the forest floor.

dung beetle species have been collected from the fur of three-toed sloths (*Bradypus tridactylus*). Beetles that eat sloth dung need to live on their hosts because the dung would be nearly impossible to find otherwise. Sloths descend from the trees to defecate only about once a week and they bury their dung immediately. The hard, dry pellets also lack the odor that draws beetles to other types of dung .

Most dung beetles eschew sloth dung when it is offered to them, but sloth-dwelling beetles pursue it avidly. While doing field work in the Amazon rainforest of Brazil, Brett Ratcliffe, curator of insects at the University of Nebraska State Museum, has seen the dung beetle *Trichillum adisi* jump from defecating sloths to feed on and lay eggs in the dung. How the beetles get back on a sloth remains a mystery, and the whole story serves as a reminder that fact can indeed be stranger than fiction.

Just as some dung beetles live on sloths in South America, others live on kangaroos in Australia. *Onthophagus parvus* and other Australian dung beetles have claws that are modified for clinging to hair, and they use these to hang around the kangaroo's anus.

"During defecation, beetles converge on the emerging pellet and two or three get a grip on the pellet and drop with it to the ground. Once on the ground with the pellet, the beetles engage in a lively tussle for possession of it, and one individual emerges as victor. This beetle may roll the pellet as much as a foot," writes Eric Matthews of the South Australian Museum in Adelaide.

Cow Trouble

While kangaroo-dwelling beetles carry the pursuit of dung to an extreme, other Australian species are also specifically adapted to deal with the pellets of dung scattered by kangaroos and other marsupials. This specialization resulted in enormous problems when Europeans introduced cows to Australia. Although the native dung beetles can roll dung that comes in pellets, most cannot make balls and they simply could not cope with the large, wet dung of cows. Gonzalo Halffter of the Instituto de Ecologia in Veracruz, Mexico, vividly describes cowpats as "masses which are sufficiently large so that even if the surface hardens, the middle stays plastic for days."

Cowpats fouled acre after acre of Australia's pastureland, up to ten percent each year. "They hardened into bricks," says Alan Hardy of the California Department of Food and Agriculture in Sacramento. Grasses couldn't grow through the cowpats and cows generally refused to graze on the grasses that grew around them.

Moreover, when dung remains on the surface, the nitrogen contained in its undigested proteins is rapidly lost to the atmosphere, thus robbing the soil of an essential nutrient. When beetles bury the dung, the nitrogen returns to the soil as it should. Another drawback to letting dung accumulate on the earth's surface is that intestinal parasites and pests, such as horn flies and face flies, breed in it.

In the 1960s, Australia decided to solve the cowpat problem by introducing dung

beetles from Africa and Argentina. Out of 41 introduced species, 22 have become established and their impact on native dung beetles has been negligible, in part because they are active at different times of the year.

Pasture fouling also became a problem in the southeastern United States during the 1950s. Thanks to the advent of commercial fertilizers and high-yield forages, cattlemen were able to stock more cows per acre of pasture. Native dung beetles were unable to cope with the increase in cowpats, many of which remained on the pasture surface for several months.

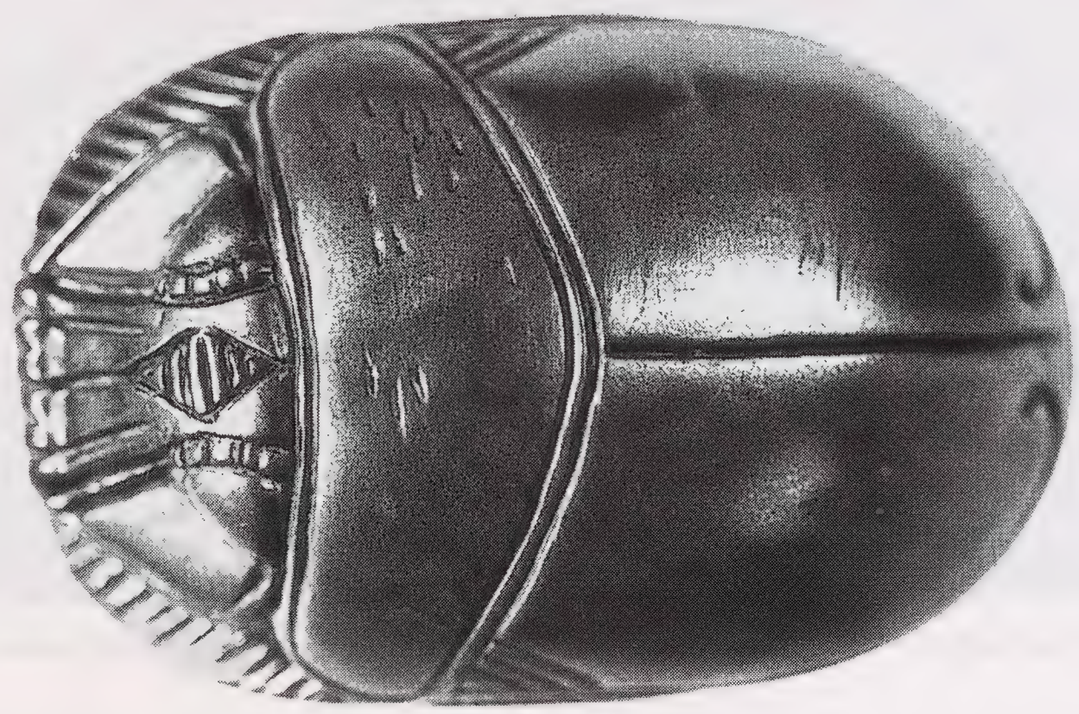
California and Hawaii also had problems with cowpat accumulation. The USDA's G. Truman Fincher worked out a staggering estimate of the rate of pasture fouling in the United States. A single cow produces 10 to 12 cowpats a day. This means that the more than 100 million cows on U.S. farms easily produce more than a billion cowpats each day. Fincher estimates that millions of these cowpats remain on the surface for months, covering the equivalent of more than 827,000 acres of pasture per year—about the size of Rhode Island and the District of Columbia combined. In relatively dry areas, the fouled land is unusable for several years.

American Exotics

Following Australia's lead, the United States decided to introduce exotic dung beetles beginning in 1966. By 1986, six species had been introduced on the mainland U.S. (in Texas, Georgia, and California), and at least four of them have become established.

Fincher defends the decision to import dung beetles. "Native species had ample opportunity to do the job," he says. "They didn't take advantage of the niche of increased cow dung." While he believes that the introduced dung beetles have improved the quality of pastures, no one knows for sure because there have been no follow-up studies on the introduced beetles.

The California Department of Food and Agriculture's Hardy and the University of Nebraska State Museum's Ratcliffe question the wisdom of introducing dung beetles to the United States. "I've never been a fan of introducing exotic species when you don't need them. It worked pretty well for Australia, but the U.S. already had native dung beetles for buffalo dung [which is similar to cowpats]," says Hardy. "Now beetles introduced here are spreading far beyond the areas where they were introduced. They're



Brett C. Ratcliffe

THE SACRED SCARAB

The ancient Egyptians worshiped the dung beetle Scarabaeus sacer, *an inch-long, ball-rolling species. To the Egyptians, ball rolling symbolized the daily movement of the sun, and the tomb of King Tutankhamun contained a pendant depicting the sun god Ra as a scarab rolling the sun across the sky. The Egyptians also believed that the sacred scarab had the power to confer rebirth after death, a belief presumably rooted in the observance of full-grown dung beetles emerging from buried brood balls.*

The Egyptians' veneration of dung beetles is evident from their ubiquitous representation in jewelry and on the walls of burial chambers. In addition, mummies' hearts were replaced by "heart scarabs," which were carved from greenstone (a dark-green rock of volcanic origin), and often had a verse from the Egyptian Book of the Dead carved on the underside of the beetle.

—Robin Meadows

popping up all over. One woman in Sacramento found [an introduced species] burying dog excrement in her lawn," says Hardy. Ratcliffe concurs, fearing that the introduced dung beetles will outcompete and displace native species. "Maybe we need to be more careful," he cautions.

Even when exotic dung beetle species have not been introduced to clean up their waste, cows upset the balance of local species by tipping the scales toward those that eat cowpats. Zimbabwe-based World Wildlife Fund researcher Allan Gardiner believes that cattle ranching has contributed to the local extinction of dung beetle species that eat wild herbivore dung, which is drier and more fibrous than cowpats. He notes that while a roller species (*Circellium bacchus*) that eats elephant dung used to live all along the eastern cape of southern Africa, today the only place on the eastern cape that supports the beetle is South Africa's Addo Elephant Park.

Over the last decade, more than 500 Zimbabweans have switched from cattle ranching to game ranching. In an ironic twist, these ranchers may now need to restock their land with beetles that can handle dung from wild animals.

Because in any given area the number of dung beetle species depends on the number of herbivore species, the diversity of dung beetles can be used as a measure of biodiversity. Mammals are highly sensitive to the rapid destruction and fragmentation of tropical rainforests, making dung beetles indirectly sensitive to habitat degradation. The Instituto de Ecologia's Halffter compared the diversity of dung beetles in two types of habitat in Palenque, a region in southeast Mexico. While an area of virtually undisturbed rainforest supported 27 species of dung beetles, an adjoining patch of clear-cut land held only five species. The edge between the two areas contained 11 species.

Besides keeping our world cleaner and telling us when ecosystems are in trouble, dung beetles remind us that there is a use for absolutely everything in nature. To paraphrase an old maxim, one species' feces is another species' meal—an offal thought to most of us.

Robin Meadows is a contributing editor to ZooGoer.

BEYOND DUNG

*Although most African dung beetles stick to dung, some species in the tropical rainforests of Southeast Asia and Central and South America have extended their tastes to animal carcasses and rotting fruit. In fact, while carrion beetles (*Silphidae*) predominate in animal carcasses in most of the world, carrion-eating dung beetles are more common in small and medium-sized carcasses, such as those of rabbits, in tropical America.*

Gonzalo Halffter of the Instituto de Ecologia in Veracruz, Mexico, has provided an evolutionary explanation for this extension of dung beetle eating habits outside of Africa. Near the end of the last ice age, about 10,000 years ago, mammals that weighed more than about 90 pounds died out in most parts of the world. Africa was the only continent that did not lose its large mammals during this mass extinction.

In tropical America, the animals that became extinct included ground sloths, equids (the horse family), and glyptodonts (armor-covered creatures related to the armadillo). Halffter hypothesizes that when these large mammals died out, the beetles that had depended on their dung were forced to find new sources of food. Diversifying to animal carcasses and rotting fruit was a small evolutionary step because the switch did not involve any behavioral or morphological changes: The beetles still bury their food and make brood balls from it, the adults continue to filter liquid food through the bristles of their mouth parts, and the larvae continue to consume decaying matter.

Three Australian dung beetle species in the genus Cephalodesmius *have also extended their eating habits beyond dung. In these species, the male gathers leaves, petals, small fruits, and perhaps a fragment of dung, and brings them underground to the female.*

She then converts these materials into a "cake" by covering them with her feces, which contain bacteria that ferment the materials into something remarkably like excrement over the course of two weeks. Much like other dung beetles, these Cephalodesmius *species subsist on liquids that drain from the decaying cake, and the female shapes fragments of the cake into brood balls and lays an egg in each one.* —Robin Meadows

AT THE ZOO

NOT YOUR AVERAGE CAVY

In the middle of the National Zoo, in front of Gibbon Ridge, an oval enclosure houses three animals. The signs tell visitors that these mammals are called maras (*Dolichotis patagonum*), but signs are often missed, and instead, people make guesses about just what those odd-but-cute-looking animals are. "Look at the wallabies!" "Is that a deer?" "I think that's one of those singing dogs." All are comments animal keeper Steve Skitek has heard. If he gets a chance, he'll try to set the speaker straight, but because that's not always possible, people frequently wander away not quite sure of what they've seen.

Maras, also known as Patagonian cavies or hares, are members of the Caviidae family—which also includes the common guinea pig (*Cavia porcellus*)—although they are different enough from the other 14 species in that family to deserve their own subfamily, Dolichotinae. *Dolichotis*, the sole genus in the subfamily, contains two species, *D. patagonum* and *D. salinicolum*; the habits of only the former have been studied to any extent.

The mara is the largest of the cavies, weighing roughly 17 to 19 pounds and growing to 20 to 30 inches long. It has a brown head and body with a white belly, the white fur extending to a fringe that borders a dark rear.

It is easier to describe a mara, perhaps, using images based on parts of other more familiar animals. One Zoo visitor described a mara as looking like a cross between a dog and a rabbit, with the head of a deer. Maras' bodies do resemble those of larger rabbits, and they also have a bit in common with ungulates such as deer. They are cursorial animals, meaning their legs are adapted for running: one mara in the wild was clocked at speeds up to 28 miles per hour over several miles. And the mara is alone among rodents in displaying stotting behavior, a sort of jumping run used by some ungulates to escape predators.

Maras live in the grasslands and scrub desert of central and southern Argentina. They are often found around shepherding outposts, perhaps because predators are wary of approaching a human residence and the maras have learned that these are safe places to live. Maras also eat what the sheep eat—mainly grasses and scrub—so an area that is good for raising sheep is also good for raising maras.

If you spend any time at all observing the maras at the National Zoo, you will notice that they don't seem particularly active. While it is true that the maras spend most of their time grazing, sleeping, and just watching their surroundings, this can obscure the fact that the maras' unique social system makes them an interesting rodent indeed.

Maras are unusual among mammals, and especially among cavies, in that they form monogamous pair bonds. Andrew B. Taber and David W. Macdonald of the University of Oxford have done extensive field research on *D. patagonum*, and they suggest three possible reasons that maras evolved a system so different from that of their polygamous cavy cousins.

They first cite resource availability. Food on the Argentinean plain is sparsely distributed, so maras must range over an average of more than 25 acres (13 soccer fields) a day to find food. The territorial males defend their feeding areas from other maras, and it would be difficult for a male to defend a region larger than what is necessary to sustain himself and his mate.

Another possible explanation for the tight pair bonds is that female maras go into heat for only a few hours at a time, once during the main breeding season of March through May, and then again right after giving birth. If a male mara monopolizes one female, he's assured of being near when she becomes receptive to his advances.

Finally, monogamy is often found among species in which males make a significant contribution to caring for young; among maras, the father provides indirect care, standing guard while the mother nurses their pups.

How maras care for their young is also quite unusual. Females have litters of one to three pups; before the pups are born, maras put aside their territorial impulses long enough to dig communal warrens for 15 or more sets of pups. One settlement observed was home to the young of 29 pairs!

Taber and Macdonald call this behavior communal "denning," as opposed to communal "breeding," because the mothers nurse only their own young. The mother identifies her young by smell and sound, stopping at the mouth of the den to whistle a call to her pups inside. Although other pups do try to steal a sip, and maras have been known to adopt orphaned young, the mothers are more likely to fend off ad-

Milton H. Tierney, Jr.

Two of the National Zoo's three maras in their recently renovated enclosure.

vances from pups not their own by pushing, shaking, or even charging at them.

And what is the father doing during this time? He stands a few feet away from the den, keeping an eye open for other pairs who might be coming to care for their own young in the communal den. Until the female has finished feeding her pups, which takes about 20 minutes, the male will rebuff other pairs' attempts to get near the den; they are forced to wait their turn.

Why would maras, who during other times of the year usually maintain a distance of more than 30 feet between pairs, adapt this communal denning behavior? Taber and Macdonald suggest that it may provide the pups increased protection from predators such as grisons or Patagonian gray foxes. With 15 or more sets of parents visiting a den each day, there is almost always an animal standing guard. Older pups have been observed keeping watch as well, so the larger the warren, the smaller the possibility that pups will be surprised by predators.

Improved thermoregulation may also have played a part in the evolution of communal denning: Because nighttime temperatures in southern Argentina can go below freezing, the shared body heat of a large number of young may contribute to the pups' survival.

The National Zoo has exhibited maras off and on for at least 30 years, and is currently home to one nine-year-old male, Bill (named for Assistant Curator of Mammals Bill Xanten), and two as yet unnamed females, aged twelve and four.

The maras feed on a special herbivore diet, supplemented with treats of green beans, carrots, and kale, a particular favorite. They're also free to munch on anything edible in the exhibit itself. In the cooler hours of the day, when they're most active, they can be seen grazing on the grass at the edge of the enclosure. Like maras in the wild, they rarely drink, getting most of their water from plants, so the new stream in the enclosure is primarily for landscaping purposes.

The maras' recently remodeled enclosure has many features designed to keep the animals happy (if such a human term can be applied here), including open grassy areas on which to graze, trees and shrubs under which the shy animals can escape the heat of the day and the noise of the crowds, and a premade den for year-round comfort. This den was provided both for pupping season and as a warm haven during the winter. It has only been used once, however, the maras preferring instead to dig their own dens. Unfortunately, Bill's den was flooded in a recent rainstorm, so the work will have to be done again.

So far, no signs of new digging have been spotted, but excavations may begin in earnest if one of the females is pregnant. While no breeding behavior has been observed, chances are good for a birth in August or September (early spring in the maras' native South America) because Bill has bonded with the younger female, and the two have had two litters together already. Unfortunately none of the five pups—two last fall and another three the following winter—survived. Despite these losses, keepers are hopeful of success this fall; they feel that the renovated yard with its increased number of hiding areas may be the key.

Obviously, there is much more to maras than meets the inexperienced eye. The next time you hurry to watch the gibbons cavorting on their ropes, be sure to spend some time checking out Bill and the girls. If you're lucky, you may get to see some new pups as well!

—*Stefanie Wulfestieg*

notes & news

Jessie Cohen/NZP

New Arrivals

May 30 was a red-letter day at the National Zoo's Great Ape House. At about 5:00 p.m., a female lowland gorilla (*Gorilla gorilla gorilla*) was born to 12-year-old Mandara and 13-year-old Gus, two of the eight gorillas residing at the Zoo. Both mother and infant are doing well, the baby spending most of her time cradled in Mandara's arms. Keepers prefer that the mother raise her baby with as little human interference as possible. For this reason, they will wait until the new gorilla is at least a year old before giving her vaccinations and a physical examination.

This is Mandara's second birth and her third experience in raising a baby gorilla. She "adopted" the now two-year-old Baraka shortly after his birth. His mother, Holoko, had no previous maternal experience and keepers surmise that Mandara simply took over. She was still nursing her own firstborn, Kejana, at the time, but had no problem taking care of two young male gorillas.

Mandara's previous mothering experience bodes well for the new little female. Because new births serve as symbols of hope for the future, the baby gorilla has been named Kigali, after the Rwandan capital.

This birth is also a symbol of hope for the lowland gorilla, a species endangered in the wild. The breeding of these animals in zoos is guided by a Species Survival Plan. The plan helps ensure the genetic diversity of the zoo gorilla population, improving the chances of survival of the species as a whole.

Jessie Cohen/NZP

The Zoo's Bird House has had some recent arrivals as well, most notably three American flamingo (*Phoenicopterus ruber*) hatchlings. The nine pairs among the Zoo's collection of 25 birds laid a total of 16 eggs this season; three of those eggs were fertile. The first two hatched June 20, with the third following on June 30, nearly one year after the Zoo's first successful hatching of an American flamingo last July 15.

As of this writing, there is one chick on exhibit; unlike its parents, the hatchling is downy white and does not yet possess a curved bill. The chick's bill will begin to curve about three weeks after hatching, and brownish-gray juvenile plumage will replace the white feathers in another couple of weeks later. The hatchlings will grow to full size in about four months, and within the next one to three years the flamingos will have attained the pink color for which they are known.

Be sure to visit the flamingo flock and check out the new chick in the enclosure behind the Bird House. And, while

notes & news

you're there, don't forget to stop by and see some of the other recent hatchlings. New faces include an African pygmy falcon, a Southern masked weaver, and two boat-billed herons.

—Stefanie Wulfestieg

Running Wild at the Zoo

FONZ held its first "Running Wild" Classic 5k race on Saturday, June 18. A total of 342 courageous runners wound their way through more than three miles of hilly Zoo trails in the early hours of this steamy morning. Alex Accetta and Meghan Dotter, the first man and woman to conquer the rugged course, won airline tickets compliments of Continental Airlines and USAir. The run was also greatly supported by The Fitness Center, the Hair Cuttery, and Oldies Xtra 104.1. The event earned net proceeds of more than $4,000 for conservation education programs at the Zoo.

"Do the Zoo"

When your family and friends come to visit, suggest they take advantage of the Sheraton Washington's "Do the Zoo" suite package. For just $99 per night, the Sheraton Washington offers a suite, complimentary hotel parking, and an array of FONZ gifts including a cuddly, plush giant panda; an audio tour and kids activity booklet; *ZooGoer*; a souvenir map and habitat brochure; and a free box of popcorn. The "Do the Zoo" package also includes a 10-percent discount in the Zoo shops and Bookstore, a 20-percent discount on stroller rental, and a 10-percent discount on the Gray Line Lil Red Trolley when tickets are purchased at the Zoo. Best of all, at the Sheraton Washington, kids under 17 stay free when using existing bedding.

The package is available now through December 31. For reservations, call 202.328.2900 locally, or toll free at 1.800.325.3535, and ask for "Sure Saver Vacation 1 Package." Some restrictions apply.

Menagerie Masquerade

If it's the end of October, then it must be time for FONZ's second annual Menagerie Masquerade gala. This year's costume party will be held Saturday, Oct. 29, from 7:30 to 11:30 p.m.

Costumes are optional, but remember: Prizes will be given for the best ones, as judged by our panel of costume specialists. Come dressed as your favorite Zoo inhabitant or create a costume never seen before!

In addition to the costume contest, Menagerie Masquerade will feature musical entertainment and dancing as well as fine food and beverages. Tickets are $30 for FONZ members and $35 for the general public; proceeds will support education programs at the Zoo. Look for details in an upcoming issue of *Wildlife Adventures*, or call 202.673.4961 for more information and to reserve tickets.

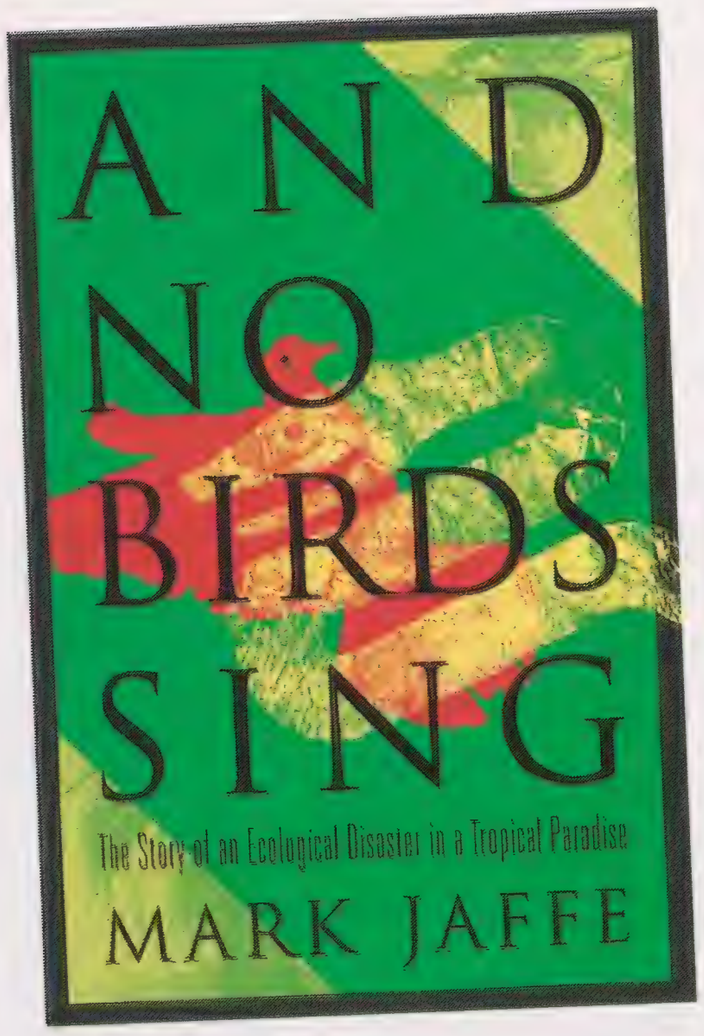
Zoo Stores

Attention holiday shoppers: The holiday season is right around the corner, and the National Zoo has a way to make your gift-buying easier. Zoo Stores will be opening in mid-October at the White Flint and Fair Oaks malls. Stock up on cuddly plush toys to play with, fascinating and fun books to read, and much, much more. The Zoo Stores have gifts for everyone on your list—and don't forget to treat yourself to something special as well.

Mark Your Calendar

September 25:	Smithsonian Fiesta Musical in celebration of Hispanic Heritage Month.
October 1 and 2:	Art and Photo Days.
October 10 to 16:	Dragon Days. Have fun learning about the Zoo's special Komodo dragons!
October 14:	FONZ Annual Meeting and Zoo-by-Night Tour.

books, naturally



And No Birds Sing: The Story of an Ecological Disaster in a Tropical Paradise. 1994. Mark Jaffe. Simon & Schuster, New York. 283 pp. hardbound, $23.00.

Imagine yourself in an island paradise. Lush tropical rainforests, warm, hazy skies. The songs and squawks of the myriad birds fill the air. Then imagine waking up one morning and realizing that you no longer hear any of those songs or squawks—the birds have all disappeared. Mark Jaffe's *And No Birds Sing* tells just such a story.

Located "in the middle of the Pacific nowhere," Guam was once home to a diverse avifauna. In the late 1970s, however, biologists studying the area noticed that the numbers of birds on the island were declining at a dramatic rate, and no one could explain why. Jaffe, working as the environmental reporter for the *Philadelphia Inquirer*, first came across the story in 1984. Five years later, he decided there was enough going on to warrant more than just a few newspaper articles, and so his book was born.

And No Birds Sing will be found in the nature or ecology section of your favorite bookstore, but it could just as easily be placed under the heading "mystery." Jaffe tells the story in a chronological fashion, so the reader discovers the new biological clues and findings in the same order as the scientists who started work on the case more than a decade ago.

In 1982, biologist Julie Savidge was hired by the Guam Division of Aquatic and Wildlife Resources (DAWR) to discover the culprit in the disappearing-bird mystery. The first half of *And No Birds Sing* follows her as she lines up and evaluates possible suspects. Savidge was quickly able to eliminate overhunting, habitat loss, and pesticide damage from her list; she was left with the choice of either disease or predation.

After conducting surveys of islanders to find out what predators they were aware of—"acting more like a social scientist than a biologist"—she became convinced that the "bad guy" behind the mysterious bird disappearance was the little-known brown tree snake (*Boiga irregularis*), "a member of the biggest subfamily and one of the largest genera [of snakes].... Just another snake in the crowd."

This snake, however, proved to be anything but typical. A nonnative species (called an "exotic" by scientists), it most likely arrived from its native New Guinea on the many ships that went through Guam after World War II.

With no natural predators on Guam, and an abundance of food, the snake quickly spread across the whole island, decimating the bird population wherever it went. The snake is especially dangerous because, as a "generalist," it will eat anything it can find. And, even though it lives in trees, it covers the ground equally well when searching for prey.

Although many of her fellow scientists initially refused to believe in such an unprecedented event, Savidge pressed on with her work of proving that one reptile species was responsible for the loss of several species of birds. A DAWR census in 1981 showed that Guam was home to 11 species of forest birds, five of which were found only on that island. By the time Julie Savidge completed her dissertation in 1986, few birds remained in the forests at all, and of the five endemic species, three—the bridled white-eye, the rufous fantail, and the Micronesian broadbill—were extinct, while the Guam

rail and the Micronesian kingfisher could be found only in zoos.

That any birds are left at all can be traced back to the work of biologist Bob Beck, who was hired by the DAWR in 1982 to find a way to save the few birds remaining on Guam. Until the bird-killer could be found and dealt with, the only way to keep any birds alive was through zoo breeding programs.

Beck enlisted the help of curators at the National, Philadelphia, and Bronx zoos to develop protocols for trapping and breeding the native birds, with the hope of eventually releasing them, if not on Guam, then at least in the wild in a habitat similar to their native one. The success of the breeding programs can be seen in many institutions, including right here at the National Zoo where Guam rails and Micronesian kingfishers share an enclosure in the Bird House.

Jessie Cohen/NZP

A Guam rail at the Zoo's Conservation and Research Center in Front Royal, Virginia.

Reintroducing the birds in the wild has been a more difficult endeavor. The ultimate goal is to release the zoo-bred birds in Guam, but with more than two million snakes on the island and no practical way to remove them—at least for the foreseeable future—a Guam release is several years away, if it can occur at all.

The neighboring and, more important, snake-free island of Rota was selected as a release site for Guam rails, but as of the book's writing a successful release had yet to be accomplished. None of the first 22 birds released survived. Biologists then released the next set of birds in a less populous area, hoping that would solve the problem. Unfortunately, the straps that attached a radio-transmitter to each of these 32 birds broke, making it impossible to verify the success of the release.

As problematic as these releases were, however, Jaffe points out that difficulties were expected. The failure of the first two release attempts does not necessarily mean that subsequent ones will fail.

While the disappearance of the birds of Guam and the attempts to keep them from becoming extinct are the main themes of *And No Birds Sing*, several other biological concerns are addressed in the book. In clear prose, Jaffe presents compact science lessons for the nonscientist. He covers everything from island biology and the scientific method to the differences between lab and field research.

Jaffe is especially concerned with the topic of exotic species; sprinkled throughout the book are references to the serious repercussions their introduction can have on ecosystems. He draws parallels between the New Guinean brown tree snake on Guam, Japanese kudzu in the southern United States, and Russian mussels in the Great Lakes.

Read this book not only to solve the mystery of the snake that ate Guam, but also to see how the solution applies to several other situations. For as Jaffe says in his preface, "Guam's woes are symbolic of problems that beset many islands and many lands, and the lessons learned there may eventually aid in saving and restoring other wildlife and wild places."

—*Stefanie Wulfestieg*

The Area Scene

The increased insect population this summer, caused by the long, cool, and very wet spring, might be driving you crazy, but the pitcher plants and sundews at the Suitland Bog are as happy as can be. The Suitland Bog is home to three species of carnivorous plants: the purple pitcher plant (*Sarracenia purpurea*), the threadleaf sundew (*Drosera filiformis*), and the spatulate-leaved sundew (*D. intermedia*). These insectivorous plants bloom in June and early July, but remain leafed and feeding through early autumn. The Suitland Bog, located in Prince George's County, is managed by the Clearwater Nature Center. For more information on visiting the Suitland Bog, call 301.297.4575.

The Bad News...

For many biologically diverse areas, fostering ecotourism means a positive shift from an economic landscape of habitat-destructive industries to a more nature-friendly one of photographers and animal-watchers. Unfortunately, even the best intentions can produce negative side effects.

Japan's Yakushima Island is home to what scientists believe is the most viable population of Japanese macaques (*Macaca fuscata*). One particularly mountainous section of the island's west coast has been designated a national park due to its unique blanket of vegetation from sea level to the tops of 6,000-foot peaks. However, to make the park accessible to a larger number of visitors, plans are in the works to widen the coastal road and add several bridges and tunnels. Along with the unavoidable loss of roadside forest, the road construction would cut the park in half, severely restricting the macaques' movements, and thereby decreasing the interaction between groups of animals that is necessary to maintain genetic diversity.

From Primate Eye, *October 1993, and* Oryx, *April 1994.*

...The Good News

One primate cousin of the macaque has fared better lately, however. World Wildlife Fund researcher Cecilia Kierulff used satellite technology to identify regions of Brazil's Atlantic coastal forest that match the habitat favored by the endangered golden lion tamarin (*Leontopithecus rosalia*). After extensive field work in those areas, she found 266 previously unrecorded tamarins, increasing the known population by nearly 30 percent. The only other known wild population (290 tamarins) is found in the Poco das Antas Biological Reserve, site of the Zoo's first golden lion tamarin reintroduction ten years ago.

Just Recycle It!

Ever worry that the sneaker wars and ever-increasing consumer trendiness might result in piles of discarded athletic shoes so high that even Charles Barkley couldn't surmount them? Well, stop worrying: Nike has developed a process to recycle sneakers. The shoes are fed whole into a granulator, reducing them to half-inch chips. Chips from leather or canvas uppers can be used as fiber-fill for everything from stuffing for medicine bottles to futon mattresses to horse-stall padding. Appropriately, the chips from rubber soles are being used primarily as components in sports surfaces such as running tracks and basketball courts. Thus far, most of the recycled shoes are defective returns from Nike's manufacturing plants, but the company has run pilot studies in Washington and Florida to explore the possibility of conducting a full-scale post-consumer recycling program.

What's In a Name?

The genus *Macropus* ("long foot") includes four species of kangaroos; if you've ever seen these creatures standing quietly, you understand how naturalists arrived at that designation. But what about the origin of the word "kangaroo"? In 1629, stranded Dutch explorer Francisco Pelsaert became the first Westerner to describe what was most likely a kangaroo, but he failed to capture or name the animal he'd seen. The first specimen was captured near the Endeavour River in New South Wales nearly 150 years later by members of an expedition led by Captain James Cook. As the story goes, Captain Cook asked his Aborigine guide what these strange, pouched animals were called and received the answer: kangaroo. It was only learned later that this reply could be translated "I don't know," or "I don't understand." By then, however, the name had stuck, and the "I-don't-know" had already become a popular zoo attraction.

Urban Animal Safari

The Washington metropolitan area provides ideal habitat for a variety of wild animal artistic creations. These lively, if inanimate, creatures range all over the region, from our most famous public places to the most secluded private lairs. Pictured here is one of these fantastic animals—do you know where to spot it? (Look for the answer in our November/December issue.)

Answer to the May/June Urban Animal Safari: Transcendence–Perfection–Bliss of the Beyond; 3428 Connecticut Avenue, NW; Washington, D.C.

—Compiled by Stefanie Wulfestieg and Courtney Coulson

Christy Bowe

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